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PRASANTHI NILAYAM

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Newsletter

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DMACS

Department of Mathematics and Computer Science

Love is the Scarcest article today

An Offering

At the Lotus Feet of

OUR MOST BELOVED MOTHER SAI

On His 86th Birthday

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The Amazing World of Continued Fractions

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I. Introduction

THE origin of the continued fractions is difficult to predict. Continued fractions are just another way of writing fractions. They have some interesting connections with a jigsaw-puzzle problem of splitting a rectangle up into squares and also with one of the oldest algorithms known to Greek mathematicians of 300 BC - Euclid's Algorithm - for computing the greatest divisor common to two numbers (gcd).

Let me take an example to introduce ***continued fraction***. We shall first convert the ***ordinary fraction*** $\frac{45}{16}$ into a *continued fraction* as shown below.

$$\frac{45}{16}=\frac{\{16+16+13\}}{16}=2+\frac{1}{\left\{1+\frac{3}{13}\right\}}=2+\frac{1}{\left\{1+\frac{1}{\{4+\frac{1}{3}\}}\right\}}$$

$$=[\mathbf{2};\mathbf{1},\mathbf{4},\mathbf{3}]$$

The semicolon after 2 represents the first digit separation. In the above example, the continued fraction is of a finite sequence and often referred to as **"finite continued fraction (FCF)"**. This leads to the representation of a **"generalized continued fraction (GCF)"** as:

$$\frac{\boldsymbol{P}}{\boldsymbol{Q}}=\boldsymbol{a_0}+\frac{\boldsymbol{b_1}}{\left\{\boldsymbol{a_1}+\frac{\boldsymbol{b_2}}{\left\{\boldsymbol{a_2}+\frac{\boldsymbol{b_3}}{\left\{\boldsymbol{a_3}+\frac{\boldsymbol{b_4}}{\{\boldsymbol{a_4}+\cdots\}}\right\}}\right\}}\right\}}$$

where a_is and b_is can be rational numbers, real numbers or complex numbers. If $b_i = 1,\ \forall i$ then the expression is called "*simple continued fraction (SCF)*". In this case, for reasons of compactness the continued fraction is generally written as $\frac{P}{Q}=[a_0;a_1,a_2,a_3,a_4,\dots]$. If the first number in the list is 0, then it represents a fraction which is less than 1.

II. Some interesting observations on FCF

- An easy method of **inverting a fraction** whose $a_0 > 0$ (alternatively finding its **reciprocal**), is to add zero in the front and shift the rest of the numbers to the right.
  For example inverting $45/16$ will lead to $16/45 = [0;\ 2, 1, 4, 3]$.
- Every finite continued fraction ending with $a_n > 1$ has two forms of representations:
  1. one ending with $a_n > 1$ i.e. $[\dots\dots, a_n]$
  2. other ending with 1 i.e. replace the final a_n by $(a_n - 1) + 1/1$ i.e. $[\dots\dots, a_{n-1}, 1]$.

  For example, $45/16$ can be represented as $[2; 1, 4, 3]$ or $[2; 1, 4, 2, 1]$
- If $[a_0;\ a_1,\dots a_{n-1}, a_n]$ is A/B and $[a_0;\ a_1,\dots a_{n-1}]$ is C/D then $[a_n;\ a_{n-1},\dots a_0] = A/C$
  For example: $[1; 1, 1, 2] = 8/5$ and $[1; 1, 1] = 3/2$ so $[2; 1, 1, 1] = 8/3$
- If $a < b$ then a/b and $(b - a)/b$ have **CFs** which are the reverse of each other when the alternative form of each reversed CF is used.
  For example: $2/13 = [0; 6, 2]$ and reversing the part after the 0 gives $[0; 2, 6]$ with alternative form $[0; 2, 5, 1]$. Now reversing the part after the 0 gives the CF of $11/13 = [0; 1, 5, 2]$
- **Euler** showed that the **CFs** $a_1, a_2,\dots a_n$ and its reversal $a_n, a_{n-1},\dots a_1$ have the same numerators.
- **Theorem:** The continued fraction of a real number is **finite** *if and only if* the real number is **rational.**

III. Continued fraction representations

A. Successive Ratios of Numbers in Fibonacci Series

For the sake of clarity, let us now look into another example: converting successive ratios of numbers in Fibonacci series into continued fraction. A Fibonacci series is written as 1, 1, 2, 3, 5, 8, 13, 21, 34…, $\{F_n = F_{\{n-1\}} + F_{\{n-2\}}\}$ ... whose successive ratios are given by the sequence of fractions $1, \frac{2}{1}, \frac{3}{2}, \frac{5}{3}, \frac{8}{5}, \frac{13}{8}, \dots \frac{F_{\{n+1\}}}{F_n}$ .... A continued fraction which describes the above successive ratios of Fibonacci numbers in the sequence can be easily derived to be $1+\frac{1}{\left\{1+\frac{1}{\left\{1+\frac{1}{\{1+\cdots\}}\right\}}\right\}}$ whose solution in the limit is $1+\frac{\sqrt{5}}{2} \approx 1.618$

B. Real Numbers

Let us see how we express a real number in terms of a continued fraction representation. Every real number "x" is a point on the real line lying between two successive integers n and $n + 1$.

$$n \le x < n+1$$
$$n = \lfloor x \rfloor$$

$x = n_1 + u_1$ where $0 \le u_1 < 1$. In a similar manner, we can generate a sequence based on the reciprocal of u_1 as $\frac{1}{u_1} = n_2 + u_2$, followed by $u_2, u_3, \ldots$ etc.

C. Square Roots

This is how we derive continued fractions for square root of any number n. For the purpose of explaining, let us take $n = 2$. Since $\sqrt{2}$ will have decimal fraction that never ends, algebraic techniques come handy. We know that $1 < \sqrt{2} < 2$. So we write $\sqrt{2} = 1 + 1/x$ which results in $0 < x < 1$. Solving for x, we get $x = \sqrt{2} + 1$. Substituting for $\sqrt{2}$ by $1 + 1/x$ we get $x = 2 + 1/x$. From this, we can easily generate the CF for $\sqrt{2}$ as $[1; 2, 2, 2, 2, 2, \ldots]$.

The steps in the algorithm for $\sqrt{n}$ are:

Step 1:

Find the nearest ***square number*** less than n, let's call it m^2, so that $m^2 < n$ and $n < (m+1)^2$.

For example, if $n = 14$ and we are trying to find the CF for $\sqrt{14}$, then 9 is the nearest square below 14, so m is 3 and n lies between $m^2 = 9$ and $(m+1)^2 = 16$. The whole number part starts off your list of numbers for the *continued fraction.*

The easy way to find the largest square number below n is to use your calculator: Find $\sqrt{n}$ and just ignore the part after the decimal point! The number showing is m.

Now, $\sqrt{n} = m + 1/x$, where n and m are whole numbers.

Step 2:

Rearrange the equation of Step 1 into the form of x **equals** an expression involving the square root which will appear as the denominator of a fraction: $x = 1/(\sqrt{n} - m)$

Step 3:

We now have a fraction with a square-root in the denominator. Use the method above to convert it into a fraction with whole numbers in the denominator. In this case, multiply top and bottom by $(\sqrt{n} + m)$ and simplify.

***either* Step 4A:**

`stop` if this expression is the *original square root* plus an integer.

***or* Step 4B:**

`start` again from **Step 1** but using the expression at the end of Step 3.

It turns out that every square root has a continued fraction that ends up as a repeating pattern.

For example:

$\sqrt{2} = [1; 2, 2, 2, 2, 2, 2, 2, 2, \ldots] = [1]$ then repeat $[2]$
$\sqrt{3} = [1; 1, 2, 1, 2, 1, 2, 1, 2, \ldots] = [1]$ then repeat $[1, 2]$
$\sqrt{4} = [2]$
$\sqrt{5} = [2; 4, 4, 4, 4, 4, 4, 4, 4, \ldots] = [2]$ then repeat $[4]$
$\sqrt{6} = [2; 2, 4, 2, 4, 2, 4, 2, 4, \ldots] = [2]$ then repeat $[2, 4]$
$\sqrt{7} = [2; 1, 1, 1, 4, 1, 1, 1, 4, \ldots] = [2]$ then repeat $[1, 1, 1, 4]$
$\sqrt{8} = [2; 1, 4, 1, 4, 1, 4, 1, 4, \ldots] = [2]$ then repeat $[1, 4]$
$\sqrt{9} = [3]$
$\sqrt{10} = [3; 6, 6, 6, 6, 6, 6, 6, 6, \ldots] = [3]$ then repeat $[6]$
$\sqrt{11} = [3; 3, 6, 3, 6, 3, 6, 3, 6, \ldots] = [3]$ then repeat $[3, 6]$
$\sqrt{12} = [3; 2, 6, 2, 6, 2, 6, 2, 6, \ldots] = [3]$ then repeat $[2, 6]$

D. Silver Means

Similar to the concept of finding a golden mean (ratio) using CF $= [1; 1,1,1,1,1 \ldots]$, can we say something about CFs $[2; 2,2,2,2, \ldots]$, $[3; 3,3,3,3,3 \ldots]$, $[4; 4,4,4,4,4,4 \ldots]$ etc.? Yes, they do have some special properties. Let $T(1) = \phi = [1; 1,1,1,1,1, \ldots]$, and $T(n) = [n; n,n,n,n,n,n, \ldots]$. It turns out that $T(n) = n + \frac{1}{T(n)}$ i.e. $T(n)$ is always n greater than its reciprocal.

Using the last property we can find values for the silver means. For instance,

$T(1) = 1.6180339 \ldots = 1 + \frac{1}{1.6180339\ldots} = 1 + 0.6180339 \ldots$
$T(2) = 2.4142135 \ldots = 2 + \frac{1}{2.4142135\ldots} = 2 + 0.4142135 \ldots$

E. Natural Logarithms

e is the base of **natural logarithms** and a number which occurs in many places in mathematics.

$$e - 1 = 1 + \cfrac{2}{\left\{2 + \cfrac{3}{\left\{3 + \cfrac{4}{\left\{4 + \cfrac{5}{\{5 + \cdots\}}\right\}}\right\}}\right\}}$$

$$= 1 + \cfrac{1}{\left\{1 + \cfrac{1}{\left\{2 + \cfrac{2}{\left\{3 + \cfrac{3}{\left\{4 + \cfrac{4}{\{5 + \cdots\}}\right\}}\right\}}\right\}}\right\}}$$

Another exciting property is:

$$\frac{\left\{e^{\{\frac{2}{k}\}} - 1\right\}}{\left\{e^{\{\frac{2}{k}\}} + 1\right\}} = [0; k, 2k, 3k, 5k, 7k, \ldots] = \tanh\left(\frac{1}{k}\right)$$

There are number of interesting properties of CF representation of π, Lucas sequence, etc. for which I direct the reader to the article written by Dr. Ron Knott available at http://www.maths.surrey.ac.uk/hosted-sites/R.Knott/Fibonacci/cfINTRO.html#notn.

Most of the material here is borrowed from his wonderful intro to the field of CFs in the above website. I am truly inspired to delve more into the amazing world of CFs. I am sure all of you will feel the same once you see the beauty of real (rational and irrational) numbers represented **by God given integers!**

Spiritual Reflections in Science

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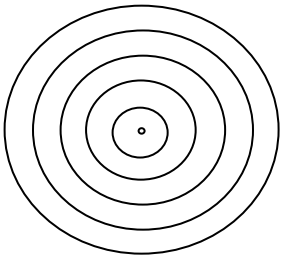
I. Paramatma-Atma-Jivatma

LET us contemplate on the family of concentric circles of all possible radii with a common center. One observes that the center is inside each circle at the core. Furthermore, one also observes that each circle is inside a circle of infinite radius (which encompasses each one of the circles of finite radii).

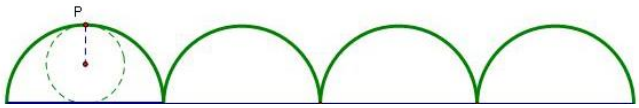


This scenario provides a spiritual reflection in the following sense. Each circle can be compared with a jivatma and the center as the atma (each jivatma has atma at its core). Also, each circle (jivatma) is contained within the circle of infinite radius (*Paramatma)*, or put another way, each circle (jivatma) is a part of the entire plane, and the totality of all circles (including the center which is a circle of radius zero) is the entire plane. That is, the totality of all infinitely many jivatmas is *Paramatma.* This reminds us of a discourse given by *Swami* in the past, in which *He* said, "Atma multiplied by infinity is *Paramatma*".

II. Cosmology

A. Relativistic Cosmology

Mathematics (in particular, Differential Geometry and Tensor Calculus) plays a crucial role in modern cosmology which is based on Einstein's theory of General Relativity under the assumption that the space around us is isotropic (same in all directions) and homogeneous (looks same at all places). One of the solutions of the Einstein's equations: $G_{ij} = 8\pi T_{ij}$ (the left side is the Einstein tensor measuring the curvature of the space-time and the right side is the stress-energy tensor) under the assumption of spatial isotropy provides a closed (compact) cosmological model. This is a periodic model starting with a big bang singularity (initial state of infinite density, pressure and temperature), attaining a maximum size and finally collapsing to another singularity, the big crunch. This model suggests that this cycle of big bang to big crunch repeats itself periodically in the cosmic time, and reveals the fact that the size of the universe is a periodic function of the cosmic time, whose graph is the well-known Cycloid (orbit of a particular point of a rolling circle) which is drawn as size of the universe versus the cosmic time in the following figure:



http://jwilson.coe.uga.edu/EMAT6680Fa05/Trandel/fa05asgn10/text10.html

It is notable that each cycle ends with a big crunch (total annihilation) immediately followed by a big bang. The momentary transition is one of the infinitely many cusps, and cannot be characterized or described by modern science as all the laws of physics break down; in fact, space and time themselves dissolve into a singularity.

B. Early Indian Cosmology

The aforementioned model is precisely what is declared in Bhagavatam, "One thousand maha-yugas---4,320,000,000 years of human reckoning constitute a single day of Brahma, a single kalpa… I have known the dreadful dissolution of the universe. I have seen all perish, again and again, at every cycle. At that terrible time, every single atom dissolves into the primal pure waters of eternity, whence all originally arose."

C. Comment & Question

At present, Science has no answer to what caused the big bang and how it happened. The Vedas declare that GOD created the universe with the primordial sound "AUM" which pervades the universe. Even science admits to an all-pervasive microwave background radiation.

Despite its success with cosmological issues, General Theory of Relativity (GTR) does not explain issues at the sub-atomic level satisfactorily. ***So, is this theory only applicable to the macrocosmic world***? In my humble opinion, it applies equally well to us, human beings.

III. Love – the force of attraction

If we consider a universe without gravitation, according to GTR, a linear perturbation is all that is required to create and propagate gravitational waves throughout the universe at the velocity of light.

If one applies GTR to the microcosmic world that exists in every human being, this gravitational force is nothing but love – the irresistible power of attraction. The linear perturbation required to trigger this big bang in every heart might be

nothing more than extending a helping hand to the needy or a gentle pat of appreciation to the deserved or even a smile of acknowledgement to an acquaintance. This is the gravitational pull of love that springs forth from every heart, transforming every being that it caresses on its way as it spreads itself at the speed of light to the different horizons. But beware; every man that wants to be a part of this solution space should satisfy the above conditions of symmetry, viz., impartiality (homogeneity) and equanimity (isotropy) and should treat himself as just another grain (egolessness) in the sands of time. This love is simply a reflection of the absolute love as quoted by Swami "In the beginning I was in perfect bliss, and there was no one to know me until I separated myself from myself in order to love myself."

IV. Dark Energy

The data gathered from astronomical observations of distant galaxies allude to the fact that our universe is going through an inflationary phase, i.e. is expanding with unexpectedly large acceleration. This would be possible only when some force acts on the universe whose nature is highly repulsive and overcomes gravitation (which is attractive). The presence of such a repulsive force is believed to be due to dark energy, the energy associated with vacuum. Intriguingly, it has been estimated that dark energy forms 70% of the entire universe. So far, the most satisfactory explanation for the presence of this energy is provided by the cosmological constant introduced by Einstein in his equations. Einstein introduced this constant in order to obtain a static universe. However, later on, when it was found that the universe is non-static (in fact expanding), he abandoned this constant stating that introducing the constant was the largest blunder of his life. To us, it seems that vacuum having energy does not make sense which, thus, leads us to believe that energy permeates even vacuum. This strange situation may be compared with the fact that each and every part of the universe (including vacuum) possesses consciousness (the divinity) in the form of energy.

V. Concluding Remark

It appears that Einstein himself was not satisfied with his theory, for he could not incorporate spiritual energy into material energy. If only he had tried looking inward he might have gotten some insight between the universe and its creator. Meanwhile, let us celebrate the good fortune we have had for, the perturbation that has caused this big bang in each of us has, as its very source, the all-powerful **divine force**. This is the general theory of relation, in practice – of the general relationship that exists between fellow men and the unique relationship that exists between **GOD** and each one of us.

- ***We must confess in all humility that, while number is a product of our mind alone, space has a reality beyond the mind whose rules we cannot completely prescribe.***

  --Carl Friedrich Gauss

- ***Mathematics is the only good metaphysics***

  --William Thomson Baron Kelvin of Largs

- ***To all of us who hold the Christian belief that God is truth, anything that is true is a fact about God, and Mathematics is a branch of theology***

  --Hilda Phoebe Hudson

- ***One cannot escape the feeling that these mathematical formulas have an independent existence and an intelligence of their own, that they are wiser than we are, wiser even than their discoverers***

  --Heinrich Hertz

And the Truth shall set You Free

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I. INTRODUCTION

JESUS said, in John 8:32, "And ye shall know the Truth, and the Truth shall make you free." That Truth, said Sai Baba in Summer Showers 1990,

> "… is eternal, is also called *Atma*, which is the core of all beings. While all other objects and beings are subject to change, like the passing clouds; *Atma* alone remains changeless.

And on Easwaramma Day 1985, Sai Baba said, "Truth is sacred. It is valid for all time —past, present, and future. It is unchanging." Knowledge, He said on 2 January 1987, " has its consummation in the discovery of Truth — which survives Past, Present and Future unaffected."

In fact, Sai Baba's basic message to us, which He states over and over in all His discourses, is that He came to give us self-realization —experience of the One, everlasting, unchanging Truth, or *Atma*. This changing world is unreal, and we are to become aware that all of us are the unchanging, everlasting Truth, or *Atma.*

Thus, while we live in an ever-changing world, it is the unchanging basis of that world that we should dwell on and become aware of and, finally, experience. Sai Baba says that this does not mean we should give up secular learning, but along with it, we should try to acquire knowledge of that which is real, everlasting, unchanging.

II. INVARIANCE, THE UNCHANGING, IN SCIENCE

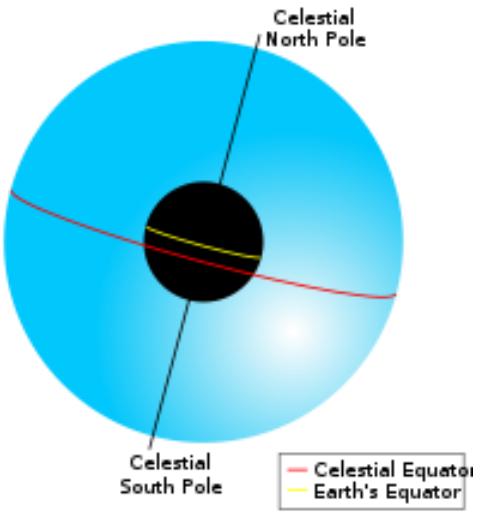
The notion of *unchanging* is an important concept in physics, mathematics, and computer science. Consider the world as we know it, or some mathematical system of transformation, or some part of a computer algorithm. We can view that world or transformation system or algorithm as something that changes state over time —the state of the system is different when it started (the past), now, and in the future. But certain properties of the system remain unchanged, and concentrating on those properties can provide better understanding. The unchanging properties could be called the *truth* of the system.

These scientific areas already have a term for these unchanging properties: invariance: an unchanging property of a transformational system is called an *invariant* of the system. The study of and use of invariants in physics, mathematics, and programming can have profound effects on these fields — not as profound as that of experiencing knowledge of the *Atma*, the ultimate Truth, but the effects are still of extreme importance in a worldly way.

A classic example of invariance in physics is the North Star, or Polaris, or Dhruva as the Hindus call it, which remains at a fixed place under the diurnal motion of the "celestial sphere", an imaginary sphere that surrounds our earth. The *Vedas* have a story about how Dhruva came to be placed as the North Star. Other peoples have similar stories! For example, the following webpage gives a Native American Indian legend of why the North Star stands still:

www.firstpeople.us/FP-Html-Legends/WhytheNorthStarStandsStill-Paiute.html

Newton's law of gravity between two pieces of matter is another example of an invariant property. It holds through time and through translation in space —it doesn't matter whether the two pieces are near the earth or have moved galaxies away (a translation in space). Also Emmy Noether proved a theorem in 1915 that relates actions of a physical system to a conservation law, which has led to the fact that invariance under time leads to the notion of conservation of energy. I don't pretend to understand this completely, but this shows how the study of invariance properties of a system, or *truths* of a physical system, can lead to important ideas.



The discovery of invariants —our truths in this world— is important in the process of classifying mathematical object, for example, in algebra, geometry, and topology. So, for example, a conformal map is a transformation of the plane that preserves angles.

Interestingly enough, there is a society at Oxford called the *Oxford University Invariant Society*, founded in 1936. It still exists, holding lectures every semester. But its name was not chosen for its significance; Graham Higman chose it randomly from a list of titles of books, in this case he was looking at Veblen's *Invariants of Quadratic Differential Forms*.

III. INVARIANTS IN COMPUTER SCIENCE

I have been a computer scientist for over 50 years —I took my first job as a mathematician-programmer in 1960. For me, the use of invariants in programming is second nature, and I cannot program without them. I have been teaching the use of loop invariants to beginners for almost 40 years, but in this article, I want to talk a bit about *class invariants*. I teach what I show below to students in the beginning programming class (using Java) at Cornell University, CS1110, which has between 150 and 300 students each semester. I want students to learn good programming practices right from the beginning, from the first program they develop.

"Object-oriented programming" deals with classes and objects. The idea can be explained simply. Suppose we want a program that maintains many different times of day, in terms of the hour of the day and the minute of the hour, along with subroutines (called methods) for changing and viewing the times. Each time of day is maintained in an *object* using two variables; the object also contains the methods for changing and viewing the variables. The *class definition* is simply a template for the objects, stating what variables and methods each object contains.

Below is the start of the class definition for such a class, `Time`:

```
  /** An object of Time maintains a time
of day */
  public class Time {
      private int hr; //Hour of the day,
in the range 0..23
      private int min; //Minute of the
hour, in the range 0..59
  }
```

Thus, each object of class `Time` will contain the two variables `hr` and `min`. They are private, so they may not be seen or changed directly from outside the object.

The two comments "`//Hour of …`" and "`//Minute of …`" give the meaning of the variables along with constraints on them. Together, the meanings and constraints form what is called the *class invariant*, for they state what must be true when an object of the class is first constructed, when a method of the object begins execution, and when a method execution terminates. The class invariant is the Truth of each object of class `Time`!

The programmer should continually refer to the class invariant as they write the methods. For example, suppose one wants to write a method that is called when an object is first created to give the fields its initial values. Such a method is called a *constructor*; we specify one here:

```
  /** Constructor: an object with minutes
m, in range 0..24*60-1 */
  public Time(int m)
```

In Java, one could create a new object for time 1 hour and 5 minutes using the expression

```
new Time(65)
```

The beginning student is likely to write the body of method `Time` as

```
  min= m;
```

thus assigning parameter `m` to object variable `min`. At this point, I tell the student: "Look at the class invariant —is it truthified by this statement?" The student must say no, because `min` may not be in the range 0..59. "Well then," I say, "the assignment you used is likely to lead to an error later on because every method will assume that the class invariant is true. You cannot use that assignment statement." The programmer, after some thinking, will use the two assignment statements:

```
  hr= m / 60;
  min= m % 60;   //(the remainder when dividing m
by 60)
```

What a beautiful, simple way, to drive home the need for and use of class invariants, the Truths of object-oriented programming!

Taking Testing to the Cloud

Dr. Devsen Kruthiventi
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***Abstract*— Cloud computing is opening up new vistas of opportunity for testing. Testing has traditionally been viewed as a necessary evil because it required a huge, dedicated infrastructure and resources that were used sporadically. Further, business applications are growing in complexity, making it difficult for organizations to build and maintain in-house testing facilities that mimic real-time environments. In broad strokes, technological virtualization has met base-level operational and financial objectives by eliminating the need for intensive capital investments. However, given the requisite set-up costs, many pioneering companies have yet to achieve the operational flexibility and scalability required to deliver on initial ROI forecasts.**

Cloud-based testing has the potential to offer a compelling combination of lower costs, pay-per-use and elimination of upfront capital expenditures (Cap-Ex). The benefits, however, extend beyond cost. The non-cost factors include utility-like, on-demand flexibility, freedom from holding assets, enhanced collaboration, greater levels of efficiency and, most importantly, reduced time-to-market for key business applications.

At the same time, cloud-based testing introduces a new set of challenges, such as data security and a lack of standards, especially in the public cloud model. Given its early stages, it is advised that CIOs and CTOs to proactively explore cloud-based testing's advantages, while remaining aware of the operational and technical challenges, before moving forward.

I. Testing and the Cloud

WHILE many companies are approaching cloud computing with cautious optimism, testing appears to be one area where they are willing to be more adventurous. There are several factors that account for this openness toward testing in the cloud:

- Testing is a periodic activity and requires new environments to be set up for each project. Test labs in companies typically sit idle for longer periods, consuming capital, power and space. Approximately 50% to 70% of the technology infrastructure earmarked for testing is underutilized, according to both anecdotal and published reports.
- Testing is considered an important but non-business-critical activity. Moving testing to the cloud is seen as a safe bet because it doesn't include sensitive corporate data and has minimal impact on the organization's business-as-usual activities.
- Applications are increasingly becoming dynamic, complex, distributed and component-based, creating a multiplicity of new challenges for testing teams. For instance, mobile and Web applications must be tested for multiple operating systems and updates, multiple browser platforms and versions, different types of hardware and a large number of concurrent users to understand their performance in real-time. The conventional approach of manually creating in-house testing environments that fully mirror these complexities and multiplicities consumes huge capital and resources.

II. Top Applications in the Cloud

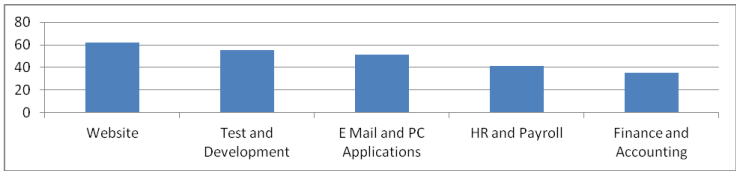


Figure1 (source Fujitsu, 2011)

Cloud's on-demand provisioning addresses these issues with one click. Moreover, the effort and resources saved in the development and testing area can be redeployed for core business pursuits. Recent research from Fujitsu (see Figure 1) suggests that testing. and application development rank second as the most likely workload to be put into the cloud after Web sites.

III. The Cost Factor

Cost reduction is the main factor influencing companies to embrace the cloud. An IDC2 survey in 2010 found economic benefits as the key driver of cloud adoption (see Figure 2).

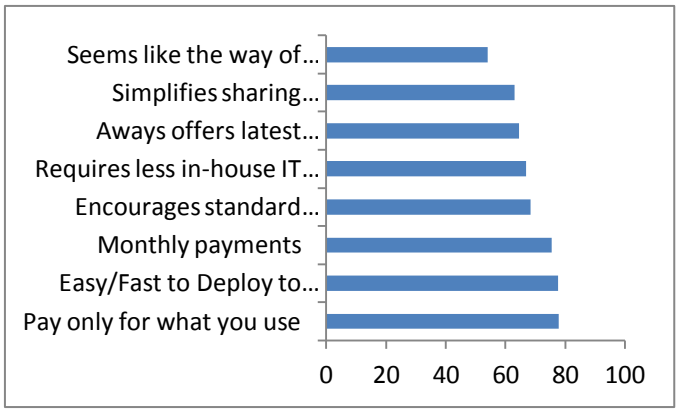


Figure 2 (source IDC)

As the global economy weakens, CIOs and CTOs continue to seek ways to contain costs and improve returns on IT investment. Testing in the cloud leverages the cloud computing infrastructure, reducing the unit cost of computing, while increasing testing effectiveness. A study of cloud- based testing service providers indicates that cost savings, including infrastructure, can vary from 40% to 70%.

Small and medium-size businesses that cannot afford high Cap-Ex also find cloud-based testing an ideal approach. Fully managed cloud (public cloud) allows companies to shift to a flexible operating expenditure model (Op-Ex), since they no longer need to make upfront investments in infrastructure, tool licenses, configuration and maintenance of test environments, and they pay only for what they use. In the case of a private cloud, infrastructure can be decommissioned once the testing process is complete, which frees organizations from incurring expensive operational costs While the cloud's ability to transform Cap-Ex to Op-Ex and reduce costs remains a work in progress, it is clear that the magnitude of cost benefits depends on various factors, such as the type cloud chosen (private, public or hybrid), the configuration of the test environment and the type of tests conducted. Further, several additional factors such as the ability of testing teams to choose the right service provider, collaborate with the service provider and understand and utilize the cloud to minimize costs also play a key role.

IV. Beyond Costs

While lower cost remains a compelling lure, there is more to cloud-based testing than expense savings. Studies estimate that about 30% of defects are attributable to inaccurate configuration of test environments. Cloud-based testing service providers offer a standardized infrastructure and pre-configured software images that are capable of reducing such errors considerably. This standardization is achieved through the use of a service catalogue, which introduces the discipline of a "library" and a commitment to meeting service level agreements. All these actions result in the faster provisioning of test environments and the ability to meet operational objectives.

Time-to-market is often restricted by traditional test environments. That's because creating on-premise test environments can be time-consuming and delay-prone. It can typically take weeks or months to set up a simple test environment for a single application, delaying its release. On-demand provisioning jumpstarts the process for forward-thinking companies, since testing resources required meeting time-to-market demands already exist in the cloud and can be provisioned instantaneously.

With cloud-based testing, organizations no longer need to worry about finding servers, procuring licenses for programs and testing tools and installing them. Service providers give testers access to scalable and ready-to-use virtual labs with a library of operating systems, test management and execution tools, middleware and storage necessary for creating a test environment that closely mirrors the real environment. Testers can run existing applications and virtual machines[3] with minimal or no rewriting and utilize pools of virtualized infrastructure to scale up the test environment within minutes.

Cloud-based test environments give testing teams greater control to build and execute tests, analyze application performance and look for bottlenecks and stress areas even while tests are running. The cloud allows testers to scale from thousands to millions of concurrent users to assess the breaking points and capacity thresholds to combat highly unpredictable demand levels. This gives testers a clearer picture of possible runtime errors, which reduces production errors and better prepares companies for peak demand times (see case study below). All of these are vital to remaining nimble in today's increasingly competitive market.

Intuit's Experience

Financial software giant Intuit needed to test its online income tax service TurboTax, following internal predictions that a significant increase in the number of income tax returns would be filed online in 2009. Up until that time, the site was tested and certified to support only 4,000 concurrent users. Intuit was particularly focused on the two days preceding the tax deadline (April 14 and 15) when it expected a spike in demand, so it tested the application for at least 200% of expected peak on those days.

Intuit selected Soasta's CloudTest On-Demand service to simulate real-time traffic. Testing initially simulated 1,000 concurrent users and was gradually ramped up using the load generated from Amazon Elastic Compute Cloud EC2, ultimately simulating 300,000 concurrent users, while 25,000 customers were filing their returns online.

Soasta worked with Intuit for 33 days. The entire exercise helped the Intuit development team identify and fix defects quickly and better understand site performance. As a result, the TurboTax site met the peak performance load on the days when it mattered most.

Sources: Soasta, Inc. and Test Magazine

Built-in cloud collaboration and management tools facilitate real-time collaboration with dispersed teams involved in the project via shared, cloud-based access to virtual machines. Once a tester logs in and executes a test, the results are available to developers, who can assess performance and fix anomalies over the cloud itself. This reduces back-and-forth communication between testers and developers regarding errors. Managers can monitor the overall progress of the project and drill down into specific tasks for review. This reduces cycle times and improves application deployment, while minimizing problems and providing users with an enhanced testing experience. For companies that are geographically dispersed and operating under tight deadlines, this allows for around-the-clock operations. Early adopters of cloud-based testing have found that their testing process is carried out five times faster on the cloud.4

V. Operational Challenges

Despite the bright upside, cloud-based testing has its limitations, too. Organizations must contend with a different set of challenges in their quest to reap cloud's benefits.

- Lack of standards: Presently, there are no universal/standard solutions to integrate public cloud resources with user companies' internal data center resources. Public cloud providers have their own architecture, operating models and pricing mechanisms and offer very little interoperability.

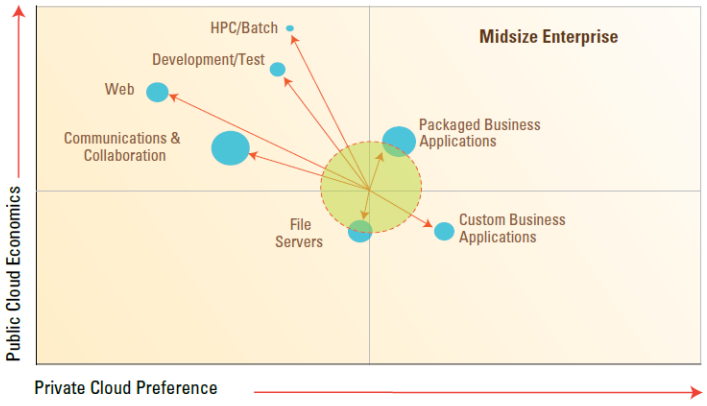
This poses a big challenge for companies when they need to switch vendors.

- Security in the public cloud: Security in the public cloud is still a major concern, and encryption techniques currently available today are considered insufficient. Procedures are being developed to improve security and performance in the public cloud. For instance, service providers are developing virtual private clouds and client partitions. The main cause for concern is that the data may be stored in a remote location beyond an organization's legal and regulatory jurisdiction.
- SLAs: Terms and conditions of cloud service are sometimes hard to understand, misleading and biased toward the vendor. Such areas include clauses governing data integrity, data preservation, data location and transfer, according to a study by The Center for Commercial Law Studies at Queen Mary, University of London 2010. Companies would do well to be diligent and proactive in sorting through these issues with their vendors.
- Infrastructure: Some cloud providers offer only limited types of configurations, technology, servers and storage, networking and bandwidth, making it difficult to create real-time test environments.
- Usage: Improper usage of cloud-based test environments can increase costs. Even though some vendors offer pay-as-you-go cloud-based testing services, this approach can be expensive or out of sync with requirements, particularly if user estimates are too conservative or wildly overblown. Companies that apply pay-as-they-go approaches must first perfect their cost models or apply process-driven estimates rather than utilizing projections that are unsupported by data.
- Planning: Testing teams should rigorously plan their test environments, from utilization periods through disassembly. They should also be aware of the associated expenses, such as cost of encrypting data, before putting testing in a cloud environment, since these requirements will consume additional CPU and memory. It's important to monitor utilization of cloud resources to avoid over-usage and over-payment.
- Performance: As public clouds are shared by numerous users, there may be cases where a company might have to wait for the required bandwidth. There may also be cases where a service provider may suddenly announce disruption of service due to a maintenance window or network outage. Some of these issues can be resolved by working closely and proactively with the service provider.

VI. Do it the Right Way

Enterprises, especially large ones, are keen on building private clouds to use their internal test infrastructure and arm themselves with security and greater control over data. Private clouds facilitate customization and allow test equipment to be reused for different projects, thereby limiting the purchase of new software and hardware. According to Gartner, "organizations will also be faced with alternatives for the use of public cloud infrastructure, and these categories of tools are still on the upward slope of the Hype Cycle pre-peak of inflated expectations. However, that this category will see fairly rapid maturation and acceptance, reaching 50% adoption in enterprises by 2015."

On the other hand, small to medium sized businesses (SMBs) are expected to lead the adoption of public cloud for application testing, as setting up a private cloud is very expensive – in some cases, around ten times the cost of a public cloud (see Figure 3).



Source: Microsoft [8]

Figure 3

Moving testing to the cloud should be viewed as a strategic initiative rather than a tactical objective. To gain confidence, create a proof of concept. It is suggested that companies carry out pilots with specific objectives in mind before making the leap. Organizations that do not have sufficient testers can seek on-demand testing services, in which service providers take complete responsibility for testing in the cloud. Here are some questions to consider before moving forward:

- What cultural change in the organization is required?
- What process changes are required?
- Who owns service management?
- What changes in organizational/financial process alignment must be made to manage/ provide for a new service?

A feasibility study is recommended to identify the scenarios in which moving testing to the cloud can benefit the organization. Testing managers should start by comparing the cost of in-house provisioning against the cost of using the cloud. It is important that organizations understand and analyze the range of benefits and proceed only if the strategy resolves a clear business need. The following steps can help companies more effectively test their applications in the cloud:

- Build understanding of the cloud: Cloud is not the answer to all testing problems. Developers and testers with strong skills should collaborate and conduct unit, functional and integration tests throughout the lifecycle. It is important to clearly understand business needs, as well as the advantages and limitations of the cloud. To get more from cloud investment, define the objectives of moving a particular testing project to the cloud.
- Formulate testing strategy: The test strategy should clearly answer what is intended to be achieved by moving testing to the cloud, including cost savings, easy access to infrastructure, reduction in cycle times, etc. The strategy

should define the type of tests to be performed in the cloud, the risks associated and the duration of the tests.

- Plan infrastructure: Test strategy also helps to define the infra- structure requirements necessary for building a test environment. Users should plan their test environments carefully by selecting the required testing tools and applications, hardware and software, bandwidth, etc. and determine how long they will require them.

VII. The Road Ahead

`Testing has been the Achilles' heel of organizations, requiring massive upfront investments in an infrastructure that tends to be used sporadically. The cloud is well-suited to testing given its resource flexibility (from provisioning and deployment through decommissioning) and reduced security concerns, compared with the issues organizations face when considering placing production data and applications in the cloud.

It is advised companies to start small and gain confidence with the benefits of cloud-based testing. Small victories build confidence over time, by speeding time to market, reducing costs (that multiply as cloud-based testing scales) and ensuring compliance with standards that demonstrate the service is both secured and reliable. Cost of operation and ownership will over time be reduced by companies that intelligently embrace pay-as-you-go or on-demand services. It is suggested that companies pilot cloud-based testing as early as they feel comfortable to ensure they gain insights and benefits as these service offerings mature and become mainstream.

It is a view that SMBs will harness public clouds, while large enterprises will leverage private clouds for their cloud-based testing services. But for organizations small and large, the road to cloud-based testing is paved with its own set of challenges. Organizations confident enough to start early and push forward, however, will reap first-mover advantages that far outweigh the pioneering risks.

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WHY RA ?

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Professor, DMACS, SSSIHL

RA stands for Real Analysis. We teach Real Analysis I & II to the second year UG MPC students. Students take Hons. in the third year, in one of the three branches. An often asked question by the students taking Physics or Chemistry Hons. is, "Why RA is being thrust upon us?" The same question is also raised by some of the teachers (reason: it is difficult to motivate the students in the course). The same question is being raised by one and all in the administration (reason: so many failures in the course).

Mathematics as taught in the schools (even in the first year UG, in our Institute) is to teach the students to play the game by the rules. A set of rules are provided (say, for differentiation) and the students are drilled to solve problems of varying difficulty using the rules. The dictum being: more you **practice**, better you become.

Once the students come to RA, they are asked to take a closure look at the rules themselves: What it may mean? How are they derived? Under what conditions do they work? What variations are possible? In essence, the **principles** behind the rules are examined. For example, differentiation is instantaneous rate of change in the value of the function f with respect to the change in the value of the variable x. Based on this principle, theorems are derived, formulas are generated, examples are given and exercises are done to clarify the concept as well as its applications. It is a transition for the students from practice based mode of learning to principles based mode of learning. In short, from drill to knowledge.

Everyone agrees that certain level of mathematics is required by all the students of MPC, irrespective of what Hons. they take later on. But some ask, why students taking Chemistry Hons. need be told about the principles behind the rules? Are the rules (information) not sufficient for them, do they need to know the principles (knowledge) behind the rules? The answer is yes! Wherever in chemistry, mathematics is applied; the situation will not come like a readymade cake to be eaten straightaway. The chemistry problem has to be formulated in the language of mathematics. The appropriate mathematical theory has to be searched. The tools therein have to be suitably adjusted to the requirements of the chemistry problem. One can play with the tools iff one knows the strength and limitations of the tool. For this, one needs to know the principles behind the tool.

There is also a larger reason for giving RA before one takes Hons. in one of the three branches. Students need to be exposed to the essential nature of mathematics. Mathematics is not a collection of tricks and tools. There is a driving **philosophy** behind its principles. Principles in turn give rules (thumb rules, if one prefers that word) for applications. The question is, how is mathematics created? One of the many aspects to answer this question is axiomatic approach.

In axiomatic approach, a set of axioms are given. Based on these axioms, a theory is built. Within the theory comes; definitions, theorems, proofs, examples & exercises. One example of axiomatic approach is Linear Algebra (LA, in short). The axioms come as a unification of many examples from different areas both within and outside mathematics. The theory created by the axiomatic approach always grows beyond the limited initial purpose with which it was proposed. This approach invariably, not only creates new mathematics, but also creates new applications of mathematics. Each axiomatic approach has its own view and vision. To name a few: Order (posets, lattices, Boolean algebras), Binary operations (groups, rings, fields), Distance (metric spaces, Banach spaces, Hilbert spaces).

A minute on the link between RA and LA. In LA, the students are taken to a new level of abstraction through axiomatic approach. One is expected to conceive of a theorem and prove or disprove it within the axiom system. It is extremely unsettling to students to do this: almost think in vacuum. It is better if the students are first exposed to theorem proving in a familiar environment. This is what RA does (before LA is given). Students are comfortable with real numbers as they think they can "visualize" it. In this familiar framework they are trained to prove theorems. The title of the prescribed text book in our Institute is *"Analysis: With an Introduction to Proof"*. RA works like a prelude to LA in this respect. It smoothens the transition from principles to philosophy.

Finally, second year UG students need to know, what to expect, if they take Mathematics Hons. It is a momentous decision in their life; they are choosing mathematics as a career option. Some of these students are expected to go on to do research in mathematics. The ability to do research in mathematics requires that one is able to see beneath and beyond the known. He has to move from practice, to principles, to philosophy and finally to **discovery** (re-search).

In summary, what mathematics syllabus does (with some contributions from RA and LA) is to take the students progressively from playing the game, to analyzing the rules, to knowing the game, to inventing games.

"**Life is a game, play it.**" --BABA
Practice: Love all
Principle: Differences exist only at the level of shapes.
At the level of substance all are same.
Ornaments are different but gold is one.
Philosophy: Advaita
Discovery: I (?)

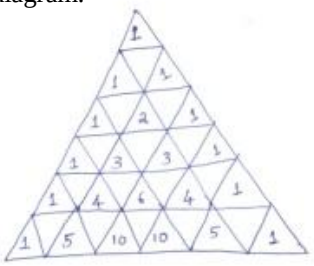
Pascal's Triangle

Swati K. and Saptala D.
Undergraduates, DMACS
Anantapur Campus, SSSIHL

I. What is Pascal's triangle ?

Pascal's triangle was named in honor of the 17th century pioneer in the field of probability. To build the triangle, start with "1" at the top, and then continue placing numbers below it is a triangular pattern.

Each number is just the two numbers above it added together except for the edges, which are all "1". Thus we get the below given diagram.



This triangle is a ready reference for finding the probability of certain combinations. For example, if you toss a coin three times and record the outcome as a sequence, there is only one combination that will give HHH, and there are three that will give two heads and one tail (HHT, HTH, THH), same for two tails and one head (TTH, THT, HTT) and one for all tails (TTT). This is the pattern in the 4th row of Pascal's triangle "1, 3, 3, 1". To find the probability of getting exactly two heads with 4 coins, consider the $(4+1)^{th}$ row, that gives the total number of outcomes for the experiment which is $1+4+6+4+1 = 16$ (2^4) and we can see that the sequence of occurrences in table. Therefore, the probability of getting two heads with four coins is 6/16.

1	4	6	4	1
HHHH	HTTT	HHTT	HHHT	TTTT

The same procedure holds good for any other similar problem, for example to determine the probability of boy child and girl child combination in a family of 6childern, consider the 7th row of Pascal's triangle add the numbers $(1+6+15+20+15+6+1) = 64$, which is the total number of arrangements of possible combinations and following table gives the particular number of occurrences of particular event

1	6	15	20	15	6	1
All Boys	1Girl 5Boys	2Girls 4Boys	3Girls 4Boys	4Girls 2Boys	5Girls 1Boy	All Girls

In fact, value at any place in Pascal's triangle can be got using ${}^nC_k$.

II. Mathematics and Nature

"*The Laws of nature are but the Mathematical thoughts of God*" – Euclid.

Mathematics is everywhere in the universe. We seldom go deep about the mathematical ideas in nature. Symmetry is one important property that is depicted in nature. Human body is excellent example of a living being with bilateral symmetry, Butterfly is another example.

Flowers, citrus fruits all exhibit radial symmetry. Hexagon is one shape which can be closely packed without gaps. Hexagonal wax cells are what bees create to store their eggs and larvae.

Volcanoes form cones, many examples of the Fibonacci spiral can be seen in nature including in the chambers of nautilus shell and the list goes on.

III. Mathematics and Spirituality

Euclid's axioms:

- Things equal to the same things are equal

This axiom is not different from what Bhagwan says "*All are one, be alike to everyone*"

- If equals are added to equals the sums are equal.
- If equals are subtracted from equals the remainders are equal.

Same as
Good deeds = Good results
Bad deeds = Bad results
The Karma Theory.

As every law of nature has a philosophical meaning, every result or pattern in numbers contains a spiritual message, look for it and you will get it.

Thoughts on Mathematics and Computer Science

Naveen M.
II M. Tech. (CS), DMACS, SSSIHL

A comprehensive compilation of Mathematics is definitely possible according to me. Before intellects can marvel at my ignorance and columnists comment in the dailies, proceeding further would be a wise (common sense) decision to be taken. Given the question, "Write a comprehensive compilation on Mathematics", that should be answered in a stipulated time, more importantly with marks tag boldly typed, definitely a 1st grader would outperform many of us to visually delight the examiner and to aesthetically present his erudition on Mathematics (Mathematics I feel can be better expressed by children, because their creativity is limitless and mathematics has no limits).

Historians though would outrightly reject this blasphemous proposal though, for they don't know "Where it all began". So, leaving the historians to argue and trace the genesis of this fountain of knowledge, humbled by our ignorance, let us gossip about this bewildering branch of knowledge.

Mathematics, in my opinion was simplified with a finite, though incomprehensible word called "abstraction". Luckily, before anyone could lose their way expounding this enigmatic abyss, some 'clever' mathematicians bounded the depths of this genesis of knowledge with what are known as 'axioms' (accepted truths), or truths that we ought to accept. Expounding further on Mathematics would be publicly revealing my ignorance, and wasting the time of geniuses surveying this article. But, an exposition should be long enough to be respectable and short enough to be interesting. Let us leave it here for the columnists to expound.

As for the galloping field of computer science, where a few honorary scientists of the age, feel that it is still in its infancy. But whatever their opinions may be, one cannot stop, but, marvel at the accomplishments and prowess at this infant genius. Computer science has presented us power to visualize, create and realize various tasks at unimaginable and breathtaking speeds. While mathematics is like the body, computer science is the ornament that adorns it. Mathematics is like intuition within, and computer science is the realization that dawns from it.

Both being inseparable, an argument concerning their relative superiority can be deemed futile, but, definitely there is a scope for a Ph. D. thesis or a research paper about it.

So why all this beautification? The culture reveals the character of the nation.

So to know about my DMACS (Department of Mathematics and Computer Science), I just felt a small introduction to things it deals with would present the tip of its magnanimity. DMACS is an angelic personification of knowledge, wisdom, research, love and since the list is endless, we shall represent the remaining part of the list with the standard (...). DMACS is a family of mathematical artists and computer scientists (my teachers), sculpting the vision envisioned by our beloved Bhagawan and humbly contributing to mission of ever expanding knowledge.

As Edsger W. Dijkstra once said:

> "For me, the first challenge for computing science is to discover how to maintain order in a finite, but very large, discrete universe that is intricately intertwined. And a second, but not less important challenge is how to mould what you have achieved in solving the first problem, into a teachable discipline: it does not suffice to hone your own intellect (that will join you in your grave); you must teach others how to hone theirs. The more you concentrate on these two challenges, the clearer you will see that they are only two sides of the same coin: teaching yourself is discovering what is teachable."

Our teachers have not stopped with Edsger Dijkstra's coin; they have been continually and tirelessly adding new dimensions to the coin, and successfully traversing the paths between {0, 1} and [0, 1]; setting benchmarks and laying milestones written in the language of our beloved Mother Sai.

Revolutions

Nagarajan
II M. Tech. (CS), DMACS, SSSIHL

Could anyone imagine that shopping, banking, TV, email, games, chatting would be just a button away? But now we carry them in our pocket! Who could imagine that our touch could be felt by a machine? But now our system too can feel your touch. Isn't it a *REVOLUTION!!!*

As someone put it "Every generation needs Revolution", we are at the stage where we need a revolution.

India has about 850 million mobile subscribers, out of which 26 million subscribers use smart phones. According to a recent survey 72% of the time is spent on gaming, internet and entertainment. And we want them within a blink of the eye. Say you type facebook.com in the browser

Loading...

Loading...

Loading...

Isn't it frustrating!!! *SPEED* is all that we need now. This is the mantra that drives the mobile industry. For this we need both handset and network to accelerate. This is the aim of 4G.

Some 4G technologies are HSPA+, WIMAX (*Worldwide Interoperability for Microwave Access*), and LTE (*Long Term Evolution*). Among these WIMAX and LTE are competing to become 4G standard. But as we see the pattern in mobile industry, LTE is a step ahead of WIMAX.

LTE is the next step forward in cellular 3G service. It is a technology based on 3GPP (3rd Generation Partnership Program) standard that aims to provide downlink speed upto 150Mbps and uplink upto 50Mbps. This is now marketed as 4G. Next question that arises in our mind is, why is it preferred?

Why LTE?

For consumers:

It provides high speed data over cellular network.

For operators:

- **Scalable Bandwidth**
- **Easy upgrade for operators**
- **High efficiency**
- **All IP**

Verizon Wireless was first to launch LTE phones and Data services in U.S. They cover about 168 cities in U.S. and are expected to cover 22 more cities this year. Their latest LTE enabled Smartphone has been launched in association with Motorola.

Droid Razor by Motorola with 4G LTE

- 1.2 GHZ Dual-Core
- Android 2.3 Gingerbread
- 1GB of RAM

Which is like my terminal capacity, is now available in mobile phone.

Samsung has introduced its best selling GALAXYTAB LTE enabled. Even giants like ***Sprint, AT&T*** are now migrating to LTE Network.

So What's In INDIA?

LTE summit 2012 is scheduled at Mumbai. ***Aircel*** and ***Huawei*** have already completed their field trial in India and are expected to launch LTE soon. And lots of research work is being done in this field.

As per the industry reports, LTE subscribers are expected to reach 380 million in more than 80 plus networks by 2015 worldwide. LTE technology is not only for mobile devices but also for fixed and portable wireless broad band access.

Are you thrilled??? Then just visit www.3gpp.org or google for more information.

Poems

Thank you, Teachers

Dear Teachers,
Thank you for making us walk the epsilon baby steps.
Thank you for making us write verses on converses.
Thank you for taking us from dilemmas to lemmas.
Thank you for making us capture infinity in finite formulas.
Thank you for making us soar in the imaginary plane, yet keep our feet firmly on the real line.
Thank you for the number of ways you shaped our lives.

- Sri. N. Uday Kiran
Asst. Prof., DMACS, SSSIHL

Desire of the Scalar Field

To become a vector field, yes I had the potential
But for this my meeting with grad was essential.

I ventured all around you know I was a hero
But I avoided Laplacians for they could make me zero.

I asked the vector operators around
Alas! The gradient was not to be found.

But one day ah! My face grew radiant
As I found approaching me a gradient.

But it was already to a vector dotted
For me only scalar multiplication was allotted.

But then integration by parts was applied
Derivative was transferred to me and I felt gratified.

- Sri. Adithya Prakash
I M. Tech. (CS), DMACS, SSSIHL

A family called DMACS

Abstraction and Axiomization is what we believe in
Contemplation and Conceptualization is that we live in
Diving deep into the ocean of Maths
Are we the family of DMACS

Means also matters not just the ends
The actual beauty lies in Maths
And not the worry where the application tends
For all of us at the DMACS

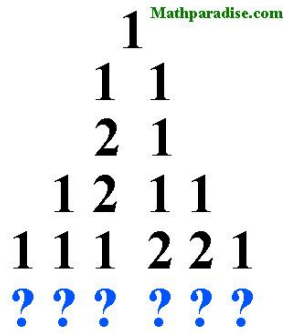
Reality we study, not just the subject
Nuances we realize of the beautiful life
Leading a life with nothing to object
For, here at DMACS, we live a true life

Pure, Applied (or) Computers may be our stream
But always we work together as a team
Living to learn and learning to live
To serve ever the lotus feet of our most beloved Sai

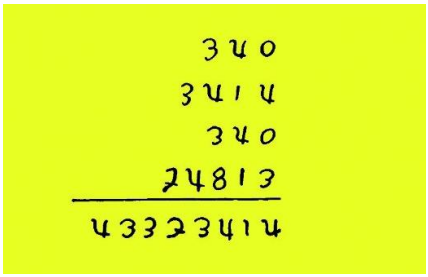
- Sri. O. Sai Prudvi
III B. Sc. (Maths), DMACS, SSSIHL

Puzzles

Q1)

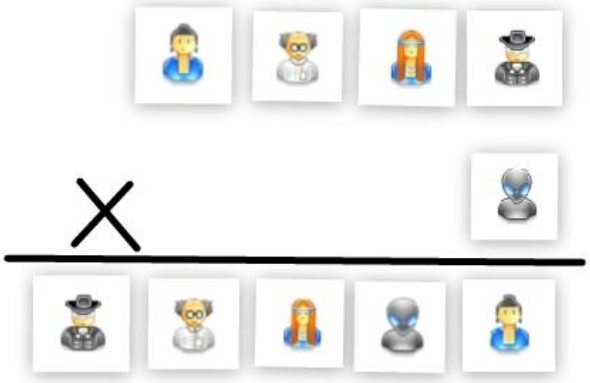


Q2)



Can you prove that the above addition sum is correct? May need to use some lateral thinking here!

Q3)



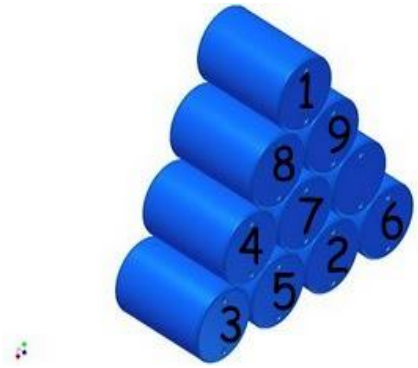
In this multiplication problem, the 5 characters shown above represent 5 different numbers. Can you figure out what number corresponds to each character? There is no zero.

Q4) What number comes next in this series:
1588, 1820, 2148, 2204, 2284, ?

Note: only +, -, x is used
Clue: we have to take the "inside" numbers out and do something with them.

Q5) Divide 110 into 2 parts so that one will be 150 percent of the other. What are the 2 numbers?

Q6) Blue Paint Drums



A paint store was showcasing its new cobalt blue paint. Each paint drum, except one, was numbered as above. A boy passing the formation noticed that each side of the pyramid has numbers that add up to 16. Impressed by the boy's observational skills, the store owner says he'll reward the boy with a free paintbrush if he can figure out how to re-arrange the drums so that the three pyramid sides sum to the smallest possible number.
[In other words, all 3 sides have to add up to the same number. What is the smallest such number?]

Hadoop proves "The best things in life are free."

- Arun K., *II M. Tech. (CS), DMACS, SSSIHL.*

Google's MapReduce

Google faced the difficulty to ingest and index the entire growing internet on a regular basis in the year 2003.

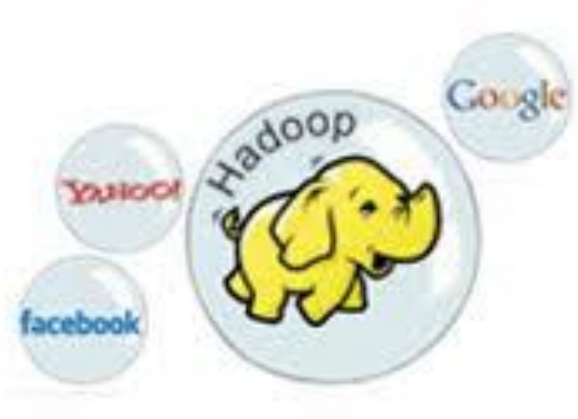
A pair of engineers from Google Labs, Jeffrey Dean and Sanjay Ghemawat, invented a technology called MapReduce which when paired with GFS, a proprietary file management technology, solved the problem.

Facebook story

When Facebook was born in 2007 its entire processing infrastructure was built around a data warehouse using a commercial RDBMS. As data set size grew from TBs to PBs the data processing jobs were taking more than a day to process and the situation was getting worse. Then they started exploring Hadoop as a way to address scaling needs. Facebook is also a contributor for the Hadoop.

Aadhaar Project of India

Giant projects like Aadhaar of INDIA are powered by Hadoop for its strengths i.e. reliability and scalability.



Google has published papers on MapReduce and GFS in 2004 which have motivated the Open Source Community to give birth to an Open Source level project named "Hadoop". The creator of Hadoop is Doug Cutting and it was named after his son's toy elephant.

Hadoop is a Java Software Framework developed for data-intensive distributed applications. This is the simplest software available till date to install, configure and write parallel programs with minimum burden on the programmer. The programmers need only to write two functions map and reduce. The parallelization is taken care by Hadoop automatically and the execution can be done on a large cluster of commodity machines with very minimal setup from the user.

- 2002-2004: An open-source crawler-based search engine, Nutch, was demonstrated on 4 nodes by part-time developers.
- 2004-2006: Google published papers on GFS and MapReduce which directly addressed scaling issues of Nutch. Two part time developers added DFS & MapReduce implementation to Nutch over two years.
- 2006-2008: Yahoo hired Doug Cutting and dedicated team. Hadoop project split out of Nutch.
- 2008: Yahoo! announced that they were using a 10,000 core Hadoop cluster to generate their search index.
- 2009: Yahoo reported that they were able to sort 1 terabyte of data in 62 seconds using a cluster of 1460 nodes running Hadoop.

Hadoop is being used as an open-source tool in the realm of distributed computing by the students, researchers and by many giant companies and organizations like Microsoft, IBM, Yahoo, Facebook, etc. for research and production.

What Hadoop does?

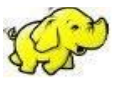
Given a large sets of data it breaks it into little chunks and spreads that information across.

Thousands of computers, asks the computer questions and receive cohesive answers.

How Hadoop does?

Hadoop is based in two components; a MapReduce computation and a distributed file system called HDFS.

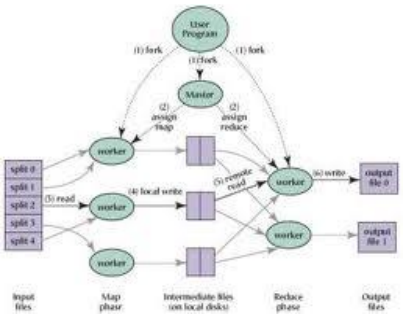
Yahoo is estimated to have spent tens of millions of dollars developing Hadoop, which remains open-source software that anyone can use or modify.



MediaGuardian Innovation award
Hadoop, an open-source community's groundbreaking project, has won the MediaGuardian Innovation award. The project was seen as great catalyst of innovation for 21st century and it surpassed Wikileaks, iPad and a host of other suggested nominees.

Hadoop@LinkedIn
LinkedIn uses modified versions of Apache's Hadoop and Pig distributions for discovering 'People You May Know'. Even Facebook uses it for this.

Hadoop behind Tweets
Twitter uses Hadoop for storing and processing tweets, log files and many other types of data generated across Twitter.



In MapReduce computation part, users specify a map function that processes a key/value pair to generate a set of intermediate key/value pairs, and a reduce function that merges all intermediate values associated with the same intermediate key. Many real world tasks are expressible in this model.

The run-time system takes care of the details of partitioning the input data, scheduling the program's execution across a set of machines, handling machine failures, and managing the required inter-machine communication.

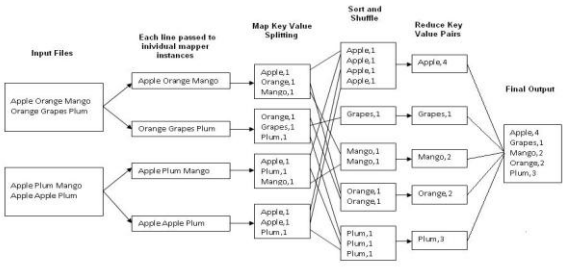
HDFS is the primary distributed storage used by Hadoop applications. A HDFS cluster primarily consists of a NameNode that manages the file system metadata and DataNodes that store the actual data. Clients contact NameNode for file metadata or file modifications and perform actual file I/O directly with the DataNodes.

Can you believe writing few lines of code can sort even TBs of data parallelly?

WordCount Example:

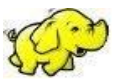
```
map(String key, String  Value)
//key: Document name
//Value: document contents
for each word w in value
   EmitIntermediate(w,"1");

reduce (String key, Iterator  values)
//key: word
//values: a list of counts
int result = 0;
for each v in values
    result +=  ParseInt(v);
Emit (AsString(result));
```



Yahoo is forming HortonWorks a new Hadoop company to accelerate the development of Hadoop and making it easier for the enterprises and vendors to install, manage and use software.

In conclusion, the Hadoop is a successful open-source project for processing very large datasets but the scalability limit of Apache Hadoop MapReduce Framework is around 4000 machines. Currently there is a work going on "Next Generation of Apache MapReduce" to address this issue and a lot more!



Solutions to Puzzles

Q1)
One (1)
One 1 (1 1)
Two 1s (2 1)
One 2 One 1 (1 2 1 1)
One 1 One 2 Two 1s (1 1 1 2 2 1)

So the next one is:
Three 1s Two 2s One 1 (3 1 2 2 1 1)

Q2)
The "numbers" are words written upside down:
one
nine
one
eight +
——
nineteen

Q3)
4 = lady with earrings
9 = nutty professor
7 = hippy chick
3 = doc holliday
8 = mork's uncle

4,973 x 8 = 39,784

Q4) Number + 4 * (middle 2 digit number) = Next number.
As in:
1588+4*58=1820
1820+4*82=2148
and so on

So 2284+4*28=2396 would be the next number.

Q5) 44 and 66

Q6)
The key is to minimize the 3 corners and maximize the center value.
Placing 0, 1, and 2 at the corners and 9 in the center, it's easy to place the rest.
One arrangement is:
0
8 5
4 9 6
1 3 7 2
is the minimum.

The joy that we cause
in the Heart of God is
the only worthwhile achievement